INTERNATIONAL JOURNAL OF PSYCHOLOGY, 1995, *30* (5), 607–616

Memory, Print Exposure, and Metacognition: Components of Reading in Chinese Children

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This study examined the relative contributions of visual and verbal memory, metacognition about reading, and print exposure to reading comprehension among 100 Chinese fifth graders. The four concurrently measured componential skills were substantially associated with reading comprehension and reliably distinguished between good and poor readers. In a hierarchical regression, after controlling for the effects of verbal intelligence, both verbal and visual memory abilities predicted unique variance in reading comprehension. The distinctness of each memory skill underscores the existence of two unique memory processes in Chinese reading. Future research should examine the longitudinal contributions of these cognitive abilities to reading comprehension.

Cette étude examine les contributions relatives des mémoires visuelle et verbale, de la métaconnaissance à l'égard de la lecture, et de l'exposition aux textes parmi 100 étudiant chinois de cinquième année primaire. Les quatre compétences constituantes, mesurées simultanément, sont effectivement associées avec la compréhension de lecture et distinguent de façon fiable les bons et les mauvais lecteurs. Une régression hierarchique une fois les effets de l'intelligence verbale contrôlés montre que les habiletés de mémoire verbale et visuelle prédisent toutes deux la variance unique dans la compréhension de lecture. Le caractère distinctif de chaque compétence de mémoire souligne l'existence de deux processus de mémoire uniques dans

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The authors thank Ms. Xiangling Xu and Mr. Jinqiu Huo, the second author's elementary school teachers, for administering and rating all the tests used in the study. The authors thank the participating fifth graders and all the teachers and students at Xiandao Elementary School, the second author's alma mater, for making the research possible. Thanks also to two anonymous reviewers for their helpful comments on an earlier version of this manuscript.

la lecture chinoise. Les recherches futures devraient examiner les contributions longitudinales de ces capacités cognitives à la compréhension de la lecture.

INTRODUCTION

Establishing the cognitive components that contribute to reading comprehension is a major task for reading researchers (Chen & Wong, 1991; Conners & Olson, 1990). Among grade school children, both higher-order and more basic processes may contribute to reading fluency. Higher-order processes include print exposure and metacognitive strategies about reading. Phonological and orthographic memory are the more basic cognitive functionings related to reading. Few investigators have studied such processes in Chinese children. A study of reading comprehension among Chinese students may help establish which cognitive processes are universal (e.g. Stevenson, Stigler, Lucker, & Lee, 1985) and which, if any, are language/orthography/culture-dependent.

Memory is important for reading comprehension (e.g. Saarnio, Oka, & Paris, 1990). In general, poor readers perform word and sentence-level recall tasks at a lower level than do good readers (for reviews, see Catts, 1989; Wagner & Torgesen, 1987). An inability to hold information in the mind cuts down on the number of connections one can make when reading. Furthermore, poor memory may cause readers to forget previous information as they concentrate on gaining new knowledge.

Previous research suggests that there exist both phonological and orthographic processing in word reading (Perfetti & Zhang, 1991). Phonological processing is among the most important skills necessary for alphabetic reading (Wagner & Torgesen, 1987). Phonological representations likewise arise in Chinese reading (e.g. Baron & Thurston, 1973; Perfetti & Zhang, 1991; Treiman, Baron, & Luk, 1981). Able readers of alphabetic scripts also eventually develop the ability to retrieve the identity of a particular word through the visual pathway (Jorm & Share, 1983). Some automatization at the word level is through the orthographic route in English, for example. A word like "height," for instance, is generally learned as an "exception" word; a word with a particular look that matches its peculiar pronunciation. Such orthographic exception words are automatized by sight.

Reading in Chinese may require even more orthographic processing. Chinese writing consists mainly of characters representing morphemes, the smallest units of meaning in language (Stevenson, 1984). The same Chinese character can have multiple meanings and pronunciations, depending upon context. An example of such a phenomenon in English is the word "bow," which has both a regular and an irregular pronunciation, and is

recognized both by sight and by meaning in context. Such words or morphemes arise frequently in Chinese. Furthermore, words generally consist of two or more characters. Visual memory for configurations of characters that represent words is, therefore, thought to be an important part of Chinese reading comprehension (e.g. Chen & Wong, 1991).

The automatization of word recognition is crucial for reading comprehension. If one is inefficient in sounding out words and in retrieving their identities through the visual route, one's ability to comprehend text is also impaired. This lack of automatization makes comprehension difficult because one's short-term memory is limited, and putting all of the words together to integrate the idea being presented in the text becomes arduous.

Another potentially significant factor in reading comprehension is metacognition about reading. Metacognition is thinking about thinking. In reference to reading comprehension, metacognition is important because it focuses on the strategies readers use to comprehend and on how they plan, monitor, and repair their comprehension (Jacobs & Paris, 1987). Skilled readers are masterly at a number of reading strategies, such as predicting what comes next in a story, checking to make sure they understand what they read, and looking forward and backward in a story (Baker & Brown, 1984). In contrast, poor readers are not as good at knowing or applying metacognitive strategies to aid them in reading comprehension. Poor readers tend to equate reading with decoding, whereas good readers focus more on the metacognitive processes involved (Wong, 1987). The focus placed on metacognitive strategies by good readers suggests that a developed sense of metacognition about reading may contribute to good reading comprehension.

Reading experience may also be a source of variation in reading ability (Cunningham & Stanovich, 1990, 1991; McBride-Chang et al., 1993; Stanovich & West, 1989). The amount of exposure to print readers experience is a significant predictor of vocabulary, word recognition skills, and reading comprehension. There is growing evidence for and interest in print exposure as a predictor of reading skills. For example, the Title Recognition Test (TRT) (Cunningham & Stanovich, 1990), which measures print exposure, was recently developed to aid in this line of investigation.

The present study examines four componential skills believed to contribute to reading comprehension in a sample of 100 fifth graders in China. The four cognitive components are metacognition about reading, print exposure, short-term verbal memory, and visual memory. All four componential skills were hypothesized to be correlated with reading comprehension and to distinguish good from poor readers. In a hierarchical multiple regression analysis, we sought to determine the relative contributions of each of these abilities to reading while controlling for verbal IQ.

METHOD

Subjects

Subjects were 100 fifth grade children from a public school in Tianjin, China. Fifty-nine of them were boys. These students were from two individual classrooms in the school. The average age was 11 years.

Procedure

All measures were group-administered to the children in their regular classrooms by two classroom teachers. The second author supervised all the testing. The tasks were administered in three separate sessions within two weeks in June of 1994. There were some missing data for those children who were absent on particular test administration days. Complete data (after listwise deletion of missing data) were available on 85 of the 100 students. The following tasks or measures were given.

Reading Comprehension

Children were required to read a short story for this test. This story was written to be of appropriate difficulty level for those toward the end of fifth grade. Students then answered five reading comprehension questions. All five questions required short answers involving outlining the passage and interpreting its meaning. The story was approximately 720 words. Students were given 30 minutes to read the story and complete all questions relating to it. Following the same grading criteria, the two teachers first rated students' short answers independently. They then compared their ratings and, when rating discrepancies occurred, discussed them and subsequently came to a consensus score for each of the five questions. Each question had a maximum score of 20 points. Possible scores ranged from 0 to 100. This test's internal consistency reliability was 0.74. This measure was used as the dependent variable in subsequent analyses.

Vocabulary

This task consisted of 16 printed words, which children were asked to define in writing. One of the two teachers graded all papers. Each answer was scored as a 0 if incorrect and a 1 if correct. This measure had an internal consistency reliability of 0.89. This test was used as a proxy for verbal IQ.

Metacognition About Reading

This questionnaire contained 10 questions with 2 alternative answers each. Some of the items were adapted from the Metacognitive Questionnaire (Jacobs & Paris, 1987) developed for English-speaking children. For each item, students were asked to check the one of two possible answers they thought was the "best reading strategy for them." For example, to the statement, "The first sentence of a paragraph," possible answers were: (a) Is the same as the others; or (b) Helps introduce the topic of the paragraph. In this case, answer (b) would be considered the more metacognitively aware of the two. The 10 items had an internal consistency reliability of 0.72.

Title Recognition Test

This test was based on the original print exposure measure created by Cunningham and Stanovich (1990). Following their work, children were given a list of seven real and three fake titles of popular Chinese books. Students were then asked to indicate which were real and fake by ticking and crossing the titles, respectively. The total score for this measure was the number of books that were correctly identified as either real or fake. The internal consistency reliability for this task was 0.60.

Verbal Memory

This measure was verbally administered by one of two classroom teachers at a rate of one stimulus per second. Students were read lists of numbers and were then asked to write down, in order, what they had heard. Only complete answers were scored as correct (one point per list); partial credit for free recall answers (out of serial order) was not given. Lists of numbers ranged from two to eight stimuli in length. Three lists of each length were administered. Students were allowed to pick up their pencils and record the numbers only after the teacher had read a list. This task had an internal consistency reliability of 0.71.

Visual Memory

This test was given in the front of the class by one of the two teachers. Initially, children were shown 25 large pictures of visual stimuli, 13 of which resembled Chinese characters and 12 of which were squiggle designs. After all 25 had been administered, a new set of 25, half of which had been presented the first time and half of which were new, were shown.

Children were asked to write down those they recognized and those they had not seen before. This test had an internal consistency reliability of 0.73.

RESULTS

Descriptive statistics on all of the children's performances on each of the six tasks are shown in Table 1. There was adequate variability among the students. Correlations among the six tasks for the 85 students with complete data are shown in Table 2.

Clearly, reading comprehension is positively associated with all five of the component skills measured. The associations of the Title Recognition Test and Metacognitive Questionnaire with reading comprehension were particularly strong. Interestingly, the Visual Memory task was not highly associated with the other measures. The moderate correlation between Visual and Verbal Memory suggested that these two memory tasks measured distinct memory processes.

To determine how well the experimental measures could distinguish those with differing reading comprehension abilities, groups of those with good and poor reading comprehension scores were formed. Good readers were defined as those with a z-score above zero on the reading comprehension measure. Poor readers were those with z-scores below zero in this measure. Results of t-tests distinguishing these groups on reading

TABLE 1
Basic Statistics on Component Abilities and Reading Comprehension

Variable	*Mean*	*SD*	*Minimum*	*Maximum*	*N*
Reading Comprehension	72.1	16.7	26	95	96
Vocabulary	11.0	4.5	1	16	95
Metacognition	9.4	1.1	4	10	90
Title Recognition	6.9	1.3	3	9	91
Verbal Memory	19.0	2.1	13	21	97
Visual Memory	21.6	2.5	11	24	98

TABLE 2
Correlations Among Component Abilities and Reading Comprehension

Variables	*1*	*2*	*3*	*4*	*5*
1 Reading Comprehension					
2 Vocabulary	0.63[b]				
3 Metacognition	0.29[a]	0.33[a]			
4 Title Recognition	0.29[a]	0.44[b]	0.23		
5 Verbal Memory	0.32[a]	0.19	−0.07	0.07	
6 Visual Memory	0.18	−0.06	−0.07	−0.13	0.16

Note: $N = 85$. [a] $P < 0.01$ (1-tailed). [b] $P < 0.001$ (1-tailed).

comprehension as well as the component abilities are shown in Table 3. As expected, poor readers scored significantly lower than good readers on all measures ($P < 0.01$, two-tailed), except Visual Memory. Poor readers were only marginally significantly lower on this variable ($P < 0.10$, two-tailed).

Although the questionnaire on Metacognition About Reading and the Title Recognition Test distinguished between good and poor readers, neither predicted additional variance in the reading comprehension measure once vocabulary was forced into a hierarchical regression. In fact, each time, the R^2 remained unchanged once either was added to the equation. Only the two memory measures contributed unique variance to reading comprehension after vocabulary was taken into account. Verbal Memory was entered into this equation before Visual Memory, because it was the more established of the two memory tasks in contributing to reading comprehension in the existing literature. In this hierarchical regression, vocabulary was entered first, producing an R^2 of 0.45. This equation was significant. Verbal Memory was added at the second step, contributing a significant additional 3% of variance ($R^2 = 0.48$). Finally, in step three, Visual Memory was entered into the equation. This variable contributed an additional 5% of variance, which was significant. Thus, the final R^2 was 0.53 (adjusted $R^2 = 0.51$). When the order of entering Visual and Verbal Memory in the same equation was reversed, similar significant variance was predicted. Thus, collectively, the three cognitive skills explained a little over 50% of the variance in reading comprehension.

TABLE 3
Mean Scores on Component Abilities and Reading Comprehension for Good and Poor Readers

Variable	*Good Readers* *Mean (SD)*	*Poor Readers* *Mean (SD)*	*T-Value*
Reading Comprehension	84.6 (6.1) $N = 53$	56.7 (12.0) $N = 43$	13.9[b]
Vocabulary	13.5 (3.1) $N = 52$	7.7 (3.8) $N = 42$	8.0[b]
Metacognition	9.7 (0.6) $N = 49$	8.9 (1.4) $N = 39$	3.2[a]
Title Recognition	7.2 (0.9) $N = 49$	6.4 (1.5) $N = 40$	2.8[a]
Verbal Memory	19.5 (1.7) $N = 53$	18.4 (2.4) $N = 43$	2.6[a]
Visual Memory	22.1 (1.9) $N = 52$	21.1 (3.1) $N = 43$	1.7[c]

[a] $P < 0.01$ (2-tailed). [b] $P < 0.001$ (2-tailed). [c] $P = 0.09$ (2-tailed).

DISCUSSION

These data represent an important first step in understanding the componential processes involved in reading comprehension. We are among the first to study metacognition, print exposure, and memory processes in Chinese children. Our measures reliably distinguish those with good and poor reading comprehension scores. One problem with these tasks is that their internal consistency reliability estimates were moderate. Future research should strive to generate more similar items within each task. However, it is worth noting that similar measures used for English speakers have also had moderate reliability estimates (e.g. Cipielewski & Stanovich, 1992; Jacobs & Paris, 1987; McBride-Chang et al., 1993). We believe that it is essential to measure these higher-order skills among readers of many languages and cultures in order to understand the nature of reading comprehension.

The data also demonstrate the important linkage between memory and reading comprehension in Chinese children. Visual and verbal memory together contributed an additional 8% of the variance in predicting reading comprehension, once vocabulary ability was taken into account. Visual memory appeared to be even more important for reading comprehension than was verbal memory. These results have important implications for future work in word reading and reading comprehension. As discussed by those concerned about the existence of reading variations among Asian students (Gleitman, 1985; Stevenson, 1984), these data show that both orthographic and phonological processes play a role in reading. Although there are many ways to conceptualize orthographic and phonological skills (e.g. Berninger, 1990; Berninger et al., 1994; Berninger, Yates, & Lester, 1991; Wagner & Torgesen, 1987), we believe that focusing on the memory component of each captures integral parts of these processes. The importance of both processes for reading is underscored by the fact that both contributed unique variance to reading comprehension in fairly sophisticated (as opposed to beginning) readers. Of course, because the data were collected simultaneously, no vigorous causal predictions can be made using them.

However, the results of the present study suggest that both visual and verbal memories are important components of reading comprehension. These memory capacities may have different characteristics in adults (Zhang & Simon, 1985) and in children. The present results should be interpreted with caution, because only fifth graders were involved in this study. Future research should concentrate on the longitudinal contributions of both orthographic and phonological memory to reading comprehension and on the development of componential skills and reading comprehension

with age. Both visual and phonological skills in relation to disabled and nondisabled readers should also be considered in future work.

Manuscript first received November 1994
Revised manuscript accepted February 1995

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